

Western Electric Company, Incorporated
Equipment Engineering Branch, Hawthorne

Printed in U.S.A.

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Issue 3 BT-431629
Appendix #2
September 20, 1935

This appendix was prepared from issue 53 of drawing T-431629

METHOD OF OPERATION

Line Circuit - Trip Circuit - Start Circuit - Time Alarm Circuit - District Selector Circuit and Line Finder Circuit - Arranged for Coin Box or Non-Coin Lines - Panel System

Change paragraphs 58, 59 and 60 to read:

58. TELL-TALE - LINE FINDER SELECTOR BRUSHES NOT TRIPPED "R" WIRING

Should the selector travel to the tell-tale position while hunting, due to the multiple brush not being tripped, the (F) relay remains operated through its outer winding. Ground on the X commutator brush and segment is thereby connected to the lead "To tell-tale circuit", giving a visual signal to the attendant. As the N commutator segment is opened at the tell-tale, the district is prevented from advancing from its normal position. The selector in this case is restored to normal manually by the attendant.

"S" WIRING

With the circuit connected per "S" wiring, the (LF) relay releases when the line finder reaches tell-tale, due to the N and C segments being open. The release of the (LF) relay releases the UP magnet, and also releases the (F) relay as soon as a sender has been found. The release of the (F) relay operates the (DS) relay which locks, operates the DOWN drive magnet and reoperates the (F) relay, returning the line finder to normal.

59. BRUSHES TRIPPED

Should the selector travel to the tell-tale position while hunting, with the multiple brush tripped, a circuit is closed from battery in the trip circuit, terminal of the H comb at the top of the multiple bank, H multiple brush of the line finder selector, cam W, winding of the (H) relay to ground on the armature of the (DS) relay, operating the (H) relay. The (H) relay operated, releases the (LF) relay, which in turn releases the (F) relay and UP magnet. The (F) relay released, opens the circuit through the tell-tale alarm and connects ground through the X commutator brush and segment, to battery through the 1000 ohm winding of the (DS) relay, which operates, in turn operating the DOWN magnet restoring the selector to normal. The receiver at the calling station being still removed from the switchhook, the relays in the line circuit are still operated and the call goes through as a new call.

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60. "T" WIRING

With the circuit connected per "T" wiring, the operating circuit for relay (DS) is held opened until relay (LF) has released, thus preventing simultaneous operation of the UP and DOWN drive magnet.

To paragraph 12 add the following:-

With "U" wiring a tip and ring cross at the "TEST" jack or a busy line finder would operate the (LF) relay which would lock and drive the line finder to overflow.

With "V" wiring, when a test set plug is inserted in the "TEST" jack of an idle line finder, the test set receives battery over the tip thru the (LF) relay of the next idle line finder of the chain. The tip of the test plug is wired to ground thru a high resistance relay which prevents the operation of the (LF) relay under this condition. When the line finder is busy, this battery is disconnected by the operation of the (MB) relay.

Add Sub-Title for paragraph 46 to read:

LINE FINDER TIME ALARM WITHOUT TRIP CIRCUIT RELEASE ("AR" WIRING)

Add the following paragraph to paragraph 46.

LINE FINDER TIME ALARM WITH TRIP CIRCUIT RELEASE ("AS" WIRING)

The circuit description for this feature will be found in the method of operation for the associated line finder time alarm with trip circuit release.

ENG. E.L.F.
9-20-35
RH

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Appendix #1.
July 16, 1925.

This M. of O. sheet was prepared from Issue 46 of T-431629.

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Add paragraph as follows:-

65. This circuit operates with non-coin service in the same manner as previously described for coin box service, except as follows:-

When non-coin service is required "N" wiring is used and message register equipment and "O" wiring is omitted. When the receiver at the calling station is replaced on the switchhook, relay (DC) releases, and it in turn, releases relay (D). The release of relay (D) closes a circuit to the R magnet advancing the switch to position 16. In position 16 relay (L) operates through its secondary winding in local circuit to ground on the back contact of relay (CI). In position 16, relay (D) operates in local circuit under control of relay (E) to ground on cam I. The operation of relay (D) closes a circuit from ground on cam M front contact of relay (L) to the R magnet, advancing the sequence switch to position 17. Relay (L) remains operated until the sequence switch advances from position 17. A momentary ground is connected to the test terminal of the sender on which the test brush is resting. This momentary ground serves no useful function, but it is not considered sufficient cause at this time to change a sequence switch cam. Should trouble resulting from this ground warrant changing cam cuttings, this work will be done at some future time. Position 17 is a passby position from ground through the inner contact of cam W. As the sequence switch advances out of position 17, relays (L) and (D) release, and battery is disconnected from the S lead of the line allowing the (CO) relay in the line circuit to release, and as the switch advances from position 17 1/2, relay (SL) releases. The (CO) relay released again connects battery and ground to the tip and ring of the line through the (L) relay. The operation of relay (DS) closes a circuit for operating relay (F). In position 18, a circuit is closed under control of the back contact of relay (D) for returning the district elevator to normal. A circuit is also closed to the back contact of relay (D) and secondary winding of relay (DS), ground at line finder segment M for operating relay (DS) which locks in local circuit to the M segment and returns the line finder elevator to normal. The operation of relay (DS) closes a circuit for operating relay (F). The M commutator segment is open at normal position and when the line finder elevator reaches normal position relay (DS), (E), (MB), and (F) will release. When the district elevator reaches normal a circuit is closed

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from the Y commutator segment for advancing the district sequence switch to position 1.

Change title to read:-

Line Circuit - Tripping Circuit - Start Circuit - Time Alarm Circuit - District Selector Circuit and Line Finder Circuit - Arranged for Coin Box or Non-Coin Lines - Panel Machine Switching System.

ENG. P.E.B.
July 16, 1925.
BMS

CHK'D. BY: G.E.H.

APP'D. BY: E. R. COOKE
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June 13, 1923 (*)
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issues.

This M. of O. sheet was prepared from Issue 38 of T-431629.

METHOD OF OPERATION

Line Circuit - Tripping Circuit - Start Circuit - Time Alarm Circuit - District Selector Circuit and Line Finder Circuit - Arranged for Coin Box Lines - Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

This common panel line finder and district selector circuit is used for passing calls originated by a dial subscriber on a flat or individual message rate line in a full mechanical office.

2. WORKING LIMITS

The line finder circuit has a maximum external loop resistance of 750 ohms and a minimum leak of 10,000 ohms. The district selector circuit has an external circuit loop resistance of 5600 ohms maximum. For trunk supervision the maximum external loop is 900 ohms.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are:-

- 3.1 To establish talking connection.
- 3.2 To supply talking battery to the calling station.
- 3.3 To connect a busy tone to the calling station if required.
- 3.4 To operate message register on a charge call.
- 3.5 This circuit is made up of the following divisions:-

3.51 The Line Circuit

Consists of the line relay (L), cut-off relay (CO), a message register, and one line circuit for each subscriber's line. When the receiver at the calling station is removed from the switchhook, battery

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is connected to the hunting (H) lead of the calling line and the associated apparatus functions and starts a line finder selector hunting for battery on the hunting lead. When the calling line is found, battery and ground from the line circuit is disconnected from the tip and ring of the line, which awaits the closure of talking battery from the associated district circuit. The associated trip circuit is also released, thus permitting another call to start in that half of the group.

3.52 A Trip Circuit

Is provided for each bank group of 20 lines, thus making 15 trip circuits on a panel line finder frame of 300 lines. Each trip circuit is divided into two units, trip unit A having access to the first 10 lines of the bank, and trip unit B having access to the last ten lines in the bank. The trip circuit mechanically trips the selector brushes of the particular bank in which the terminals of its associated lines appear and connects to a starting circuit. Each trip circuit is equipped with an emergency plug and jack, by means of which a defective trip circuit can be immediately replaced by an emergency circuit.

3.53 The Starting Circuit

Controls the routing of calls to the respective line finder selectors and starts an idle selector hunting over the line terminals for the calling line. It also releases at the same time a trip relay in the associated trip unit, thus permitting another call to start in any other group. There is one starting circuit for each frame of 300 lines. The circuit consists of three 200 type distributing selectors, one of which permits the distributing of this circuit so as to give each line equal preference. The other two distributing selectors distribute the calls uniformly to the respective line finder selectors. Each regular starting circuit is provided with means for testing any line finder circuit and is equipped with an emergency plug and jack, immediately replacing the regular circuit with an emergency circuit at any time.

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3.54 A Line Finder Circuit

Is arranged to find the calling subscriber's line and connect it with the various switching apparatus necessary to complete a call. Each line finder circuit is permanently connected to a district selector circuit and consists of a power driven selector having fifteen sets of contact brushes, wired in multiple and one set of brushes associated with each line bank. At the same time, the line finder selector starts upward hunting for the calling line, the associated district selector circuit functions and selects an idle sender. This circuit also includes a MAKE BUSY jack and TEST jack.

3.55 The District Selector Circuit

Which is the other end of the line finder selector is provided with a magnet-driven selector switch, by means of which an idle sender is selected and associated with the district until all selections have been completed, when the sender is discharged. The district selector circuit is selector ended and selects and connects to the proper outgoing trunk under control of a sender, for the completion of an originating call. It also supplies talking battery to the calling station, and connects battery for the operation of the message register in the line circuit on a charge call and connects the busy tone to the calling station, if required.

3.56 The Line Finder Time Alarm Circuit

Is for the purpose of giving visual and audible signals to the attendant when an originating call is not connected to a line finder in the specified time period.

3.6 Panel Line Finder Frame

3.61 A panel line finder frame consists of 15 banks (at times known as panels), of line terminals, each bank consisting of 20 sets of multiple line terminals, making a total capacity of 300 lines. The multiple terminals appear on both sides of the bank and the set consists of 4 terminals, namely, tip, (T), ring (R), sleeve (S) and hunting (H). Each frame and bank has a capacity of 60 line finder selectors, 30 selectors mounted on the front of the frame and the other 30 selectors mounted on the rear of the frame. This number of selectors for each

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300 lines may be reduced to 40 or 28 selectors. The arrangement of the selectors may be accomplished by splitting the line multiple bank of the frame in the following manner:-

3.611 Each 60 selector bank on the frame is split in the center and arranged for a cross connection cable so that the first or bottom line on one side of the split will connect to and appear at the last or top line of the other half of the bank. This practice is used when 60 line finder selectors are required for 300 lines.

3.612 Each 60 selector bank on a frame is split into three sections of 20 selectors, two of these sections to be arranged for cross connection to each other and the other sections to be cross connected to the corresponding bank section of another frame. This practice is used where 40 selectors are required for 300 lines, thus permitting 900 lines to be accommodated on two frames.

3.613 A 56 selector bank is split in four sections of 15 selectors each, the first and second sections to be arranged for cross connection to each other and the third and fourth sections arranged for cross connection to each other. The practice is used where 28 selectors are required in each 300 lines, thus permitting 600 lines to be accommodated on the one frame.

3.62 Each group of selectors for each 300 lines is divided into two sub-groups, "A" and "B". The "A" sub-group of the selectors is on one side of the transposition split, and the B sub-group is on the other side of the transposition split. By this method, a call originating in a group of 20 lines, causes a selector in the "A" or "B" sub-group to start hunting, the sub-group depending upon the calling line being in the first or last 10 lines of the group. Should two calls in the same group originate at the same time, one being in the first 10 lines and the other being in the last 10 lines, the two selectors will start, one selector in sub-group A and the other in sub-group B. Should all the line finders in the sub-group be busy, a call originating with the corresponding 10 lines will start a selector in the adjacent sub-group.

3.63 When both sub-groups of selectors for 300 lines are on the same frame, two TRIP magnets are used; one magnet on the

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front and the other magnet on the rear of the frame. When both sub-group selectors are on separate frames, four TRIP magnets shall be used, one on the front and one on the rear of the frame.

4. CONNECTING CIRCUITS

4.1 A standard subscriber's sender circuit and a standard incoming circuit.

DESCRIPTION OF OPERATION

ORIGINATING CALLS

5. The operation for a call originating in the first 10 lines of a group is as follows:- When the receiver is removed from the switchhook at the calling station, the (L) relay in the line circuit operates over the subscriber's loop. The line (L) relay operated, operates the (BA) relay thru its inner winding. The (BA) relay operated, (a) operates the (TR) relay over a circuit from ground on the armature of the (BA) relay, the (K) relay normal, 700 ohm outer winding of the (TR) relay, the (A), (STA), and (STB) relays normal, to battery on the armature of the STP-G magnet, (b) connects battery thru the outer winding of the (BA) relay, to lead B of the time alarm circuit, (c) connects the alarm lamp (BA) across leads C and A of the time alarm circuit, and (d) connects battery thru the inner winding of the (O) relay, in multiple with the 18-AC resistance to the H terminal at the top of a group to determine in which group a call originated when the selector goes to overflow. The (TR) relay operated, performs the following functions: (a) Energizes the two TRIP magnets which operate the trip rods, one on the front and one on the rear of the frame, (b) opens the locking series circuit thru the (TR) relays of the other bank groups as hereinafter described, (c) locks in a circuit from ground thru its 600 ohm inner winding and make contact, terminal and brush of the G group distributor selector, the (C), (CA), and (SB) relays normal, to battery thru 1000 ohm resistance in parallel with the windings of the (ST-A) relay, which operates.

6. The (ST-A) relay operated, (a) operates the (STP-G magnet, and the (K) relay, (b) short circuits the 500 ohm winding of the (CA) relay, preventing it from operating and starting the line finder in sub-group "B" as described under ALL SELECTORS IN ONE SUB-GROUP BUSY. The (GA) relay released, disconnects the K commutator ground from the K lead.

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11. If the (TR) relay has not been short-circuited and released, by the K commutator, 2 seconds after the interrupter springs I, III and V open, then the (TR) relay is short-circuited and released in a circuit from ground on the (STA) relay operated, thru the interrupter springs II and IV and (KF) relay operated. Interrupter spring VI which closes at the same time as II and IV springs, closes a circuit operating the (KA) relay which locks, and operates an alarm circuit at the trouble desk. When the (STA) relay releases, locking ground is removed from the (KF) relay, which releases. The (KA) relay is released by the operation of a key at the trouble desk which disconnects its locking ground.
12. When the selector brushes make contact with the terminals associated with the calling line, the H terminal is closed thru, operating the (O) relay in the trip circuit and the (H) relay in the line finder circuit, CIRCUIT:- Battery in the trip circuit, thru 500 ohm winding of the (O) relay, and 500 ohm resistance connected in parallel, make contact of the (L) relay, lead H, the H selector brush and segment, cam W, winding of the (H) relay, the (DS) relay normal to ground. With the (H) relay operated, the 50 ohm non-inductive shunt is connected around its windings to ground on its armature for the purpose of increasing the amount of current thru the 500 ohm winding of the (O) relay, thus speeding its operation. This is necessary on account of the short time during which the H brush makes contact with the H terminal before the circuit is opened by the overthrow of the selector. The (H) relay operated, opens the holding circuit of the (LF) relay, which does not release immediately on account of a circuit being closed from ground thru the C commutator brush and segment to battery thru both windings of the (LF) relay in series. The (LF) relay is thus held operated until the brushes are centered on terminals of the calling line. When the circuit thru the C commutator segment is opened, the (LF) relay releases, (a) opening the circuit thru the UP magnet, which stops the selector brushes on the terminals of the calling line, (b) opens the circuit thru the 800 ohm winding of the (F) relay, in order that when the holding circuit thru its 1000 ohm winding is opened, by the district sender selector seizing an idle sender, the (F) relay releases, (C) closes a circuit, operating the (SL) relay. CIRCUIT:- Ground, on the M commutator, the (LF) relay normal, (E) relay operated, winding of the (SL) relay, cam C, the (D) relay operated to battery on the break contact of the (DS) relay.

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NOTE:-

The adjustment of the C commutator brush with relation to the tripped H multiple brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit thru both windings of the (LF) relay is opened, by the operation of the (H) relay, when the H brush makes contact with the H terminal to which the battery is connected. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the line terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time, the holding circuit thru both windings of the (LF) relay is opened at the C commutator, releasing the (LF) relay. The (LF) relay released releases the UP magnet. The selector then drops into place, thus centering the brushes on the line terminals.

13. The (O) relay operated, opens the locking circuit of the (K) relay. The (K) relay is very slow in releasing, to hold the (O) relay operated, thru its 1500 ohm winding in order to permit the (BA) relay to release before the (O) relay, otherwise another finder may be started by this call.
14. The (SL) relay operated, operates the (CO) relay in the line circuit from battery on its armature. This same battery is connected to the multiple sleeve terminals of the line at the final frame, making the line test busy to all hunting final selectors and terminating call. The operation of the (SL) relay also closes a circuit operating the district (CH) and (I) relays. CIRCUIT:- Ground, on N commutator brush and segment, the (F) relay normal, (SL) relay operated, cam O to battery thru the 600 ohm winding of the (CH) relay, in parallel with battery thru cam R, and 800 ohm winding of the district (L) relay.
15. The (CO) relay operated, releases the line (L) relay which in turn releases the (BA) relay. The (BA) relay released, opens the circuit thru the (O) and (H) relay, which release. Another call may now start within this same group of 10 lines if the starting circuit is ready for the call. The operation for a call originating in the last 10 lines in a group of 20 will be similar to that already described for the first 10 lines, except that the (BA-1), (K-1), (O-1), (TR-1), (ST-B), and (CB) relays involved instead of the (BA), (K), (OK), (TR), (STA) and (GA) relays.
16. If there is a simultaneous call on both the first and last 10 lines of the group of 20 lines, relays in both sub-groups will operate as already described, starting two line finder selectors in different sub-groups at the same time. In this case, the inner windings of the (O) and (O-1) relays are connected together thru the make contact of the

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(BA) and (BA-1) relays. The (O) and (O-1) relays will therefore operate in parallel when the H brush of either or both line finder selectors, make contact with the H terminal of the calling line.

17. With the switch in position 1 and the (CH) relay operated a circuit is closed from ground on cam H, (CS) relay normal, (CH) relay operated, to battery thru the selector time alarm circuit (not shown), which functions after an undue length of time giving a visual and audible signal. The (L) relay operated, closes a circuit advancing the district switch to position 2. CIRCUIT:- Battery thru the R magnet, cam B, (L) relay operated to ground on cam M. As the switch advances from position 1, the circuits thru the (L) and (CH) relays are opened, releasing the relays and disconnecting the selector time alarm circuit. In position 1-1/2 to 2, the associated sender is held busy thru cam E by ground on cam H.

18. With the switch in position 2, the (CI) relay reoperates thru its outer winding to ground on cam S and remains operated until the switch advances from position 10. The (CI) relay operated, (a) connects ground on cam S to the test brush of the sender selector, for a busy test to replace ground on cam C as the switch advances from position 2, (b) closes the tip side of the fundamental circuit thru to the sender, (c) operates the (CI-1) relay. With the switch in position 2 and the F relay released the tip and ring leads from the calling line are closed thru to the F and R leads of the associated sender circuit thus permitting a dialing tone to be transmitted back over the dialing circuit from the associated sender as an indication that the apparatus is ready to receive a call by the operation of the station dial. The tip side of the dialing circuit is closed from the T lead of the line, the (F) relay normal, cam P, to the T brush of the sender selector. The ring side of the dialing circuit is closed from the R lead of the line, the (F) relay normal, winding of the (DC) relay, cam Q, to the R brush in the sender selector.

19. After the sender functions, the fundamental circuit is established for the operation of the district (L) relay and the stepping relay in the sender. CIRCUIT:- Ground in the sender circuit. FT brush, (CI) relay operated, cam L to battery thru the 1200 ohm winding of the (L) relay which operates and locks thru its 1200 ohm winding thru cam L, to ground over the FT lead and advances to position 3, from ground on cam M.

20. When the (CI-1) relay operated (switch in position 2), battery thru the outer winding of the (D) relay was connected thru cams V and U to the sender control (SC) lead. The (D) relay whose windings are differentially connected, does not release at this time due to the high resistance in the SC lead in the associated sender. If this circuit is

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used with 3 digit senders this high resistance ground is only momentarily and is disconnected from the SC lead when a relay in the sender operates. When the switch enters position 3, the 600 ohm winding of the (CH) relay is connected thru cam U in parallel with the outer winding of the (D) relay to the SC lead and may under favorable conditions, operate if used with 2 digit senders but performs no useful function at this time. When used with 3 digit senders, the SC lead is open and the (CH) relay therefore, cannot operate.

DISTRICT BRUSH AND GROUP SELECTION

21. With the switch in position 3, the UP magnet is operated for brush selection from ground on cam M. As the selector moves upward in position 3, carrying the commutator brushes over the commutator segment, the A segment and brush intermittently connect ground to the tip side of the fundamental circuit thru cams K and L, holding the (L) relay operated but successively short circuiting the stepping relay in the associated sender circuit thus releasing and permitting its reoperation until the proper brush has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay released, opens the circuit thru the UP magnet, thereby stopping the upward movement of the selector and advances the switch to position 4. CIRCUIT:- Ground on cam M, (L) relay to normal, cam B to battery thru the R magnet. In position 4, the trip magnet TM is operated from ground on cam S and the (L) relay is operated and locked to ground over the fundamental circuit as previously described advancing the switch to position 5.
22. With the switch in position 5, the UP magnet is reoperated and the TRIP magnet being operated, causes the previously selected set of brushes to trip when the selector starts upward. As the selector moves upward for group selection, carrying the brushes over the commutator segment, the "B" brush and segment intermittently connect ground to the tip side of the fundamental circuit thru cam L, holding the district (L) relay operated but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its reoperation until the proper group has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay which in turn opens the circuit thru the UP magnet and advances the switch to position 6.
23. The high resistance ground on the SC lead is replaced by ground thru 500 ohms to insure the operation of the (CH) relay, and occurs during group selections, if two digit senders are used or when the sender advances from its "district group selection" position if three digit senders are used. With the switch in position 6, the circuit is closed thru the

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line finder N commutator brush and segment, (F) relay normal, (SL) relay operated, cams O and R to battery thru the 800 ohm winding of the (L) relay which operates. The (L) relay operated, advances the switch to position 7. CIRCUIT:- Battery thru the R magnet, cam B, (L) relay operated, cam M, (D) relay operated to ground.

TRUNK HUNTING

24. Should the first trunk in the group in which the selector is hunting be idle, the (L) relay releases as the switch leaves position 6-1/4. When the switch enters position 6-1/2, ground is connected to the sleeve of the selected trunk thru cam M, (L) relay normal, cam E as a busy condition until the switch advances to position 7-3/4.

25. Should the first trunk in the group in which the selector is hunting be busy, the (L) relay is held operated thru its inner winding from ground on the sleeve terminal of the busy trunk. With the switch in position 7, the UP magnet is reoperated from ground on cam M under control of the (L) relay and the selector travels upward until an idle trunk is found. When an idle trunk is found, the locking circuit thru the inner winding of the (L) relay is opened but the relay does not release immediately due to a circuit being closed from battery thru its outer winding, cam R to ground thru the C commutator brush and segment. When the brushes are centered on the trunk terminals, the circuit thru the C commutator segment is opened and the (L) relay releases in turn opening the circuit thru the UP magnet which stops the selector brushes on the terminals of the selected trunk. The (L) relay released, connects ground on cam M to the sleeve of the selected trunk sleeve as a temporary busy condition and advances the switch to position 8.

"C" COMMUTATOR

26. The adjustment of the C commutator brush, with relation to the tripped sleeve multiple brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit thru the inner winding of the (L) relay is opened by the sleeve brush, leaving the busy terminal and making contact with the sleeve terminal of the idle trunk. The UP magnet therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the trunk terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time, the other holding circuit thru the outer winding of the (L) relay is opened at the C commutator, releasing the relay which disconnects ground from the commutator feed bar (G) and releases the UP magnet. The selector then drops into place thus centering the brushes on the trunk terminals. During trunk hunting (in position 7 only), the commutator feed ground is supplied from ground on cam M under the control of the (L) relay. This prevents the reoperation of the (L) relay by the closing of a circuit between the C commutator brush and segment on the overthrow of the selector or as it drops into place.

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27. As the switch advances from position 7, ground on cam H, is removed from the fundamental ring lead (FR) and in position 7-3/4 ground is connected thru cam E to the sleeve of the selected trunk as a permanent busy condition. With the switch in position 8, a circuit is closed from ground, (CH) relay operated, cams O and R to battery thru the outer winding of the (L) relay which operates and advances the switch to position 9. In position 9, the tip and ring of the outgoing trunk fundamental circuit are closed to the tip and ring terminals of the selected trunk for selection beyond thru the FT and FR brushes of the sender selector and cams F and G respectively. After selection beyond has been completed, ground in the sender is removed from the SC lead, (if 2 digit senders are used or a high resistance ground is connected to the SC lead (if 3 digit senders are used) releasing the (CH) relay, in turn releasing the (L) relay. The (L) relay released, advances the switch to position 10. As the switch leaves position 9-1/2, the dialing circuit is opened at cams P and Q, and in position 9-3/4, the tip and ring leads of the line finder are closed thru cams P and Q respectively, to ground and 24 volt battery in the district, operating the (DC) relay which is held operated under the control of the station switchhook. In position 9-1/4, the circuit thru the inner winding of the (D) relay is opened at cam I but the (D) relay being slow in releasing will not release but will lock under control of the (DC) relay when the switch enters position 9-3/4. From position 9-3/4 to 17-1/4, the (SL) relay locks to battery on its contact, thru cam T. The (D) relay is also made slow in releasing to hold the selector should the switchhook at the calling station be momentarily depressed.

TALKING SELECTIONS

28. With the switch in position 10, the sender circuit functions and connects ground to the FT lead causing the (L) relay to operate and lock thru its inner winding over the tip of the fundamental circuit as previously described for district selection. The (L) relay operated advances the switch for talking selection. CIRCUIT:- Battery thru the R magnet, cam B, (L) relay operated to ground on cam M. As the switch advances ground is intermittently connected to the tip side of the fundamental circuit thru cam E, holding the (L) relay operated but successively short circuiting and permitting the reoperation of the stepping relay in the sender circuit. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened releasing the (L) relay. The (L) relay released opens the circuit thru the R magnet stopping the switch in position 12, 13 or 14 depending upon the class of call. As the switch leaves position 10, the holding circuit of the (CI) relay is transferred from its outer to its inner winding. CIRCUIT:- Ground on cam E, (L) relay operated, cam V, (CI-1) relay operated, cam U (E) relay operated to battery thru the inner winding of the (CI) relay.

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The release of the (L) relay opens the holding circuit of the (CI) relay which releases in turn releasing the (CI-1) relay and disconnecting the sender from the district circuit.

CALLED PARTY ANSWERS

29. When the receiver at the called station is removed from the switch-hook, with the switch in position 11 or 12, ground and battery on the tip and ring respectively from the incoming circuit, operates the (CS) relay. The (CS) relay operated, closes a circuit from ground on cam (H), (CS) relay, operated cam N, winding of the (I) relay to battery thru the III contacts of the 149-J interrupter. When the interrupter contacts close the (I) relay operates and locks to battery thru its make contact. The (CH) relay operates under control of the (I) relay when the (V contact of the interrupter closes. The (CH) relay operated, locks thru its 600 ohm winding and cam O to ground on its armature.
30. The purpose of the 149-J interrupter is to delay the operation of the (CH) relay for at least two seconds after the (CS) relay operates. This is to prevent the false operation of the (CH) relay should the (CS) relay operate momentarily before the called party answers due to any line disturbances.

OPERATOR ANSWERS

31. On operator calls the switch advances to position 13 during talking selections and when the operator answers by inserting a plug of an answering cord in the answering jack of the trunk the (CS) relay operates on reverse battery and ground over the trunk. The (I) relay may operate as the switch passes positions 11 and 12 but releases as the switch advances to position 12. The (CS) relay operated closes a circuit from ground on cam H, (CS) relay operated, cam R to battery thru the outer winding of the (L) relay which operates and advances the switch to position 14. As the switch advances from position 13-1/4 the (CS) releases, opening the circuit thru the outer winding of the (L) relay. When the switch enters position 13-1/2, the relay locks thru its inner winding and cam E to ground on the sleeve terminal of the selected operator's trunk. When the switch advances from position 13-1/2 ground is disconnected at cam H from the armature of the (CS) relay preventing the selector time alarm circuit from functioning during the talking period, and the repeating coil circuit is disconnected from the calling line, releasing the (DG) relay. When the switch enters position 13-3/4 the T and R leads of the calling line are connected directly to the T and R brushes of the selected operator's trunk thru cams P and Q respectively and control of the

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locking circuit thru the inner winding of the (D) relay is transferred from the contacts of the (DC) relay to the upper contacts of cam J. In position 14 a checking tone circuit is closed over the sleeve of the operator's trunk, inner contact of cam E, (L) relay operated, upper contacts of cam V, cam Y, 2 m.f. condenser, lower outer and upper inner contacts of cam X, the S brush and terminal of the line finder bank, to ground thru the winding of the (CO) relay for number checking. Since the T and R leads of the calling station are not connected thru the repeating coil but are connected direct, the operator may collect or refund the coin or operate the message register at will.

DISCONNECTION - REGULAR CALL

32. When the called station disconnects, the (CS) relay releases, connecting ground from cam H, (CS) relay normal, (CH) relay operated to the selector time alarm circuit which operates and functions if the calling station does not disconnect within a reasonable length of time, thereby operating a signal to the attendant. When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases in turn releasing the (D) relay. The (D) relay released, advances the switch to position 16. As the switch advances from position 12, the (I) relay releases. As the switch advances from position 13-3/4, the T and R multiple terminals are opened at cams F and G and as the switch advances from position 14-1/2 the S terminal is opened at cam E making the trunk available to other hunting selectors.

MESSAGE REGISTER

33. As the switch enters position 14-3/4, the (CI) relay operates thru its inner winding. CIRCUIT:- Battery, inner winding of the (CI) relay, (E) relay operated, cam T to ground. The (CI) relay operated locks thru its outer winding, (in position 15-1/2) if the sender selector switch is connected to a busy sender as described in paragraph 7 and operates the (CI-1) and (F) relays and the STP-SS magnet when the switch advances from position 15-1/2, the circuit thru the inner winding of the (CI) relay is opened at cam H. In position 16, the STP-SS magnet is energized and as sender is reselected as described in paragraph 7, the (CI) relay releasing when an idle sender is found. In position 16 the (D) relay operates thru its inner winding from ground on cam I under control of the (E) relay. As the switch enters position 16-1/2, the selector group register operates from ground on cam K thru cams L and K.
34. The (CI) relay released, (a) releases the (F) and (CI-1) relay, (b) immediately makes the test terminals of the selected sender busy from ground on cam H, (E) relay operated and (CI) relay normal and (c) operates the (L) relay thru its outer winding from ground on the armature of the

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(CI) relay and cam R. The (L) relay operated, locks thru its inner winding to ground on cam E, and advances the switch to position 17. CIRCUIT:- Battery, R magnet, cam B, (L) relay operated, cam M, (D) relay operated to ground. When the switch enters position 16-3/4 the test terminals of selected sender is held busy from ground, (D) relay operated, thru cam M, (L) relay operated and cam C.

35. In position 17, the (CI) relay operates thru its inner winding from ground on cam I, operating the (CI-1) relay and a circuit is closed (if provided, A wiring) from battery on the (SL) relay, operated outer contacts of cam T, thru the three 18-AN resistances in parallel (CH) relay operated, the H brush and terminal of the line finder over lead H, (L) relay normal to ground thru the message register (MR) operating the message register. During the registering period, another line finder selector hunting over the line terminals in the same sub-group, will not stop its brushes on the multiple terminals of this line at this time, since the (H) relay of the hunting line finder is shunted by the 5 ohm message register while passing over the H terminal of the registering line.

COLLECTING OR RETURNING THE COIN

36. In position 17, the tip and ring of the calling line are closed thru to the T and R leads of the sender thru cams P and Q and T and R brushes of the sender selector switch respectively for the purpose of collecting or returning the deposited coin depending on whether the (CH) relay is operated or normal. (When the (CH) relay is operated, ground is connected to the FR lead operating a coin collect relay in the sender. If the (CH) relay is normal, a coin refund relay in the sender circuit operates. After the sender has collected or refunded the money as the case may be, ground is connected to the SC lead, cam V, (CI-1) relay operated, cam U to battery thru the outer winding of the (D) relay which releases differentially. The (D) relay released, advances the switch to position 18. As the switch advances to position 18, the circuits of the (D), (SL), (CH), (CI), and (L) relays are opened which release and the battery for operating the message register is disconnected from lead H. The release of the (CI) relay releases the (CI-1) relay, discharges the sender and removes the busy test from the test brush of the sender selector. The release of the (SL) relay disconnects battery from lead S releasing the (CO) relay thus restoring the line circuit to normal.

37. As the district switch enters position 18, the (DS) relay of the line finder circuit operates. CIRCUIT:- Ground, M commutator brush and segment, 350 ohm winding of the (DS) relay, cam N, (D) relay normal to battery on the break contacts of the (DS) relay. The (DS) relay

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operated: (a) Locks to battery on its make contact (b) operates the (F) relay thru the outer winding which remains operated, the line finder selector is returned to normal, (c) operates the line finder DOWN magnet from ground on its armature, restoring the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from the M commutator segment, releasing the (E), and (DS) relays. The (DS) relay released releases the (F) relay.

38. When the district switch is in position 18, the district DOWN magnet operates from ground on the break contact of the (D) relay, thru cam D, restoring the district selector to normal. As the district selector returns to normal, ground on the Y commutator brush and segment is closed, thru cam B to battery thru the R magnet, advancing the switch to position 1 or normal. As the switch leaves position 18, the DOWN magnet is released and in position 18-1/4, the circuit thru the inner winding of the (MB) relay is opened at cam I, releasing the relay and restoring the circuit to normal.

DISCONNECT - CALL TO OPERATOR

39. If the plug of the cord is removed from the trunk jack before the calling station disconnects the line relay in the trunk circuit operates, thereby holding the busy ground on the sleeve terminals of the trunk, and preventing the district (L) relay from releasing. When the receiver at the calling station is replaced on the switchhook, and the plug of the answering cord is removed from the trunk jack, the (DC) relay releases disconnecting ground from the sleeve of the trunk, thereby releasing the (L) relay, which advances the switch to position 15. As the switch advances from position 14-1/4, the locking circuit thru the inner winding of the (D) relay is opened at cam J, releasing the relay. The (D) relay released, advances the district switch to position 16, from ground on its break contact, thru cam D. In position 16, a sender is reselected, for the purposes of making coin tests and returning the coin, if the operator has not done so. From this point the circuit functions as described in paragraphs 33 to 38, except that the message register is not operated nor the coin collected due to the (CH) relay being normal.

DISCONNECTION ON ABANDONED CALL

(a) Disconnection Before Line Finder Selector Finds Line

40. Should the calling subscriber replace the receiver on the switchhook before the hunting selector finds the line, the (L) relay in the line circuit releases, removing the battery from the H terminal on the

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multiple bank. Assuming the calling line to be in sub-group A, the release of the (L) relay, also releases the (BA) relay. The (TR) relay having operated, locks and operates the (STA) relay which operates the (LF) relay in the line finder circuit in turn starting the selector to hunt for the calling line as described under an "Originating Call". The selector, therefore, travels to the top of the bank, and the H brush of the selector will then make contact with the H terminal at the top of the multiple bank operating the (H) relay, from ground on the break contact of the (DS) relay, winding of the (H) relay, cam W, H brush of the selector, to battery on the terminal of the H comb supplied thru the 1,000 ohms non-inductive winding of the (BA-1) relay and the break contact of the (BA-1) and (BA) relays. The (H) relay operated, releases the (LF) relay as its locking circuit is opened when the (STA) relay releases. The (LF) relay released releases the (F) relay. At tell tale position the N commutator is open, thus opening the circuit thru the UP magnet, stopping the selector, and preventing the district switch from advancing from normal when the (F) relay releases at the release of the (LF) relay. The (F) relay released, operates the (DS) relay thru its 1000 ohm winding from ground on the X commutator brush and segment. The (DS) relay operated, operates the DOWN magnet, restoring the selector to normal.

PREMATURE DISCONNECTION (POSITIONS 2 TO 6)

41. When the receiver is replaced on the switchhook at the calling station while the district switch is in positions 2 to 6, the dialing circuit is opened at the calling station, causing the sender circuit to function returning the coin and connect a direct ground to the SC lead, causing the (D) relay to release differentially due to an increased current flowing thru the outer winding of the relay. The (D) relay released, (a) operates the (DS) relay, which restores the line finder selector to normal as described under "Disconnection - Regular Call" (paragraph 37). (b) Opens the circuit thru the (SL) relay, which releases. The (SL) relay released, disconnects battery from lead S, releasing the (CO) relay in the line circuit and advances the district switch to position 6 from ground on the N commutator and break contact of the (F) and (SL) relays, and cam D. With the district switch in position 6, the same ground thru cam D to battery energizes the district selector DOWN magnet, restoring the selector to normal. When the selector reaches normal ground from the Y commutator, brush and segment and cam B advances the switch to normal.

POSITIONS 7 TO 9

42. Should the receiver be replaced on the switchhook while the district switch is in positions 7 to 9, the circuit continues to function, and trunk hunting and selection beyond will take place

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in the same manner as previously described advancing the sender circuit, which returns the coin and advances the district switch to position 11. As the switch advances from position 9-1/4 the (D) relay releases, advancing the switch to position 16 and operating the (DS) relay. The (DS) relay released, restores the line finder selector to normal. (A sender may be reselected as the switch passes thru positions 14-3/4 to 15-1/2, but performs no useful function. When the line finder selector reaches normal, ground is removed from the M commutator, releasing the (DS), (E) and (SL) relays. The (E) relay released, releases the (D) relay. The (SL) relay released advances the switch to position 17, and ground on the break contact of the (D) relay advances the switch to position 18. The district selector switch is restored to normal as previously described in paragraph 38.

POSITION 10

43. If the calling subscriber disconnects while the district is in position 10, the (DC) relay releases, in turn releasing the (D) relay. The (D) relay released advances the district to position 16. As the (DS) relay cannot operate in position 10, a sender is re-selected for the purpose of returning the coin, and the circuit functions and disconnects as previously described in paragraphs 33 to 39.

ALL SELECTIONS IN ONE SUB-GROUP BUSY

44. If all the selectors in sub-group A for example, are busy the (CA) relay operates over a circuit from ground on the armature of the (MB) relay in the line finder circuit, thru the make contact of all other operated (MB) relays in sub-group A over lead CH to the starting circuit, 500 ohms winding of the (CA) relay to battery thru the 600 ohm resistance (C). The (CA) relay operated, transfers the circuit thru the 600 ohm winding of the (TR) relay in the trip circuit, from the winding of the (STA) relay, to break thru the winding of the (SA) relay and break contact of the (SB) relay. When a call is now received, the (SA) relay operates in series with the 600 ohm winding of the (TR) relay in turn operating the (ST-B) relay. The (ST-B) relay operated, operates the (K) relay, starts a selector in the B sub-group hunting for the calling line and closes the locking circuit thru the 1,000 ohm winding and make contact of the (CA) relay. This is to prevent the release of the (CA) relay should the selector become available in the A sub-group while a call is going thru the B sub-group. If all the selectors in the sub-group B are busy, the operation is similar except that the (CB), (SB) and (ST-A) relays now operate. The (ST-A) relay operated, starts the selector of the A sub-group hunting, as explained before.

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ALL SELECTORS IN BOTH SUB-GROUPS BUSY

45. If all the selectors in both sub-groups are busy, both the (CA) and (CB) relays are operated. Should a call be received in either sub-group under these conditions, the corresponding (SA) or (SB) relay operates, but neither the (STA) or (STB) relay operates as the circuit to ground on the armature of the (CA) and (CB) relays are opened. When a call is received in the A or B sub-group while all selectors are busy, the special message register (MR) and the starting circuit operates thru the make contact of the (SA) relay to ground on the armature of the (CB) relay, if the call is in sub-group A or thru the make contact of the (SB) relay to ground on the armature of the (CA) relay, if the call is in sub-group "B". The message register thus indicates the number of calls originated while all the line finder selectors are busy.

LINE FINDER TIME ALARM

46. If a line finder does not find a subscriber's line within 35 seconds after the receiver at the calling station is removed from the switchhook, an alarm is given in the following manner:- When the receiver at the calling station is removed from the switchhook, the line (L) relays operate, operating the (BA) relay. The (BA) relay operated, connects battery to the contacts of the 152-D interrupter in the time alarm circuit. CIRCUIT:- Battery, non-inductive winding and make contact of the (BA) relay, lead B, winding of the B (frame) relay in the time alarm circuit, brush and terminal 1 of the start arc of the time alarm selector, (A) relay normal to ground on the interrupter contact. When the interrupter contact closes, the (B) relay operates. The (A) relay (frame does not operate), however, due to its windings being short circuited by ground on the interrupter. When the interrupter contact opens, the short circuit is removed from the winding of the (A) relay which now operates in series with the winding and make contact of the (B) relay to ground on the armature of the (B) relay, thus holding both relays operated. The next closure of the interrupter operates the STP magnet. CIRCUIT:- Ground on the interrupter contact, (A) relay operated, terminal 1 and brush of the step arc of the selector, winding of the STP magnet to battery. When the interrupter contacts open, the STP magnet releases and steps its brushes one step on its back stroke. The selector brushes thus advances one step for each make and break of the interrupter contacts, which gives an interval of seven seconds, until the fifth terminal of the selector is reached, and the circuit thru the interrupter is opened. The BA lamp in the trip circuit now lights. CIRCUIT:- Battery, the (A) frame relay operated, terminal 5

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and brush of the LAMP arc of the selector, lead A, (BA) relay operated, BA lamp, lead C to ground thru the winding of the (B) (aisle) relay in the time alarm circuit which operates. The (B) relay operated, operates the (A) (aisle) relay. The (A) relay operated, lights the aisle pilot lamp and the main or monitoring board lamp thru their respective auxiliary alarm circuits. When the source of trouble is removed and the (BA) relay in the trip circuit releases and the circuit over leads A and B are opened, in turn releasing both the frame and aisle (A) and (B) relays, extinguishing the aisle and main or monitoring board lamps and silencing the alarm. The release of the (B) (frame) relay, also closes a circuit from ground on its armature thru terminal 5 and bridging brush of the RETURN arc of the selector, to battery thru the break contact and winding of the STEP magnet, which operates and steps the selector brushes to terminal 6, in which position it waits the next closure of lead B. Should the (BA) relay release before his terminal is reached by the selector, the (A) and (B) (frame) relays release. The (B) relay released, causes the selector to advance to the next normal position, awaiting the closure of lead B as previously described. The operation of the 188-A key steps the selector brushes to the next normal position by way of the STEP bridging brush and 5, 10, 15 or 20 terminals as the case may be. If the selector is in position 6, 11, or 16 (normal), when the (BA) relay operates, the operation would have been the same as described for position 1.

WIPING OF GROUP DISTRIBUTOR BANK

47. The wiring of the two group distributor arcs to the regular G distributing selector bank shown on the regular starting circuit and of the emergency G distributor selector bank is shown in detail in the circuit associated with the series circuit of the emergency jack and contact of the (TR) and (TR-1) relay for the 15 groups of the panel line finder frame. For a complete frame of 300 lines, the wiring of the terminals for both arcs of each G distributor selector is shown in a table on the drawing. As the trip circuit is divided into two units, A and B, calls originating in the first 10 lines of the group of 20 lines are connected thru trip unit A and a terminal and brush of the G arc, normally having access to the line finders in sub-group A. Calls originating in the last 10 lines of the group are connected thru trip unit B and the corresponding terminal and brush of the other arc, normally having access to the line finders in sub-group B. This arrangement permits the distributing of the 30 trip circuit A and B units, in sub-groups A and B respectively in the starting circuit, so as to give each group an equal preference, thus preventing any one group from having the preference over the other group. This is accomplished by the G selector being advanced one step to the next group after each call. The series circuit thru the contacts of the

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(TR) and (TR-1) relays, permits the passing of a call thru a number of idle groups with the same speed as though the call originated on the line within the group having the preference at that time. Should two or more calls start in two or more groups at the same time, the group nearest the one having the preference at that time, will be completed first, because of the series locking arrangement of the (TR) or (TR-1) relays holding the relays of this group locked and releasing the other relay.

48. The (TR) relay in any group locks from ground thru its 600 ohm winding and make contact, jack 10 terminal and brush of the associated arc of the G selector to battery in the starting circuit thru jack 15. The (TR-1) relay locks thru its 600 ohm winding and make contact, jack 12, corresponding terminal and brush of the associated G arc to the starting circuit thru jack 16. Jacks 10 and 12 of each group circuit are wired to the selector terminals and jacks 9 and 11 of the next group circuit so that the double selector may be given preference to one group, this group being idle and a call originates in some other group a circuit is closed back thru the intervening jacks and break contacts of the intervening relays of each group until the terminal at which the distributor brush is resting on is reached. Assume a call originates in group 15 and is passing thru trip unit A and the brushes of the G distributor selector are resting on the first group terminals, which is terminal 1. The locking circuit for the (TR) relay will be as follows:- Thru the 600 ohm winding and make contact of the (TR) relay, jack 10 of group 15, jack 11, break contacts of the (TR-1) and (TR) relays, and jack 10 of group 14 (not shown) thru all other groups in the same manner to jack 10 in group 1, terminal 1 and brush of the selector to jack 15 of the starting circuit. It will be seen that if two calls start at the same time, in two different groups, causing the (TR) relays in the two groups to operate together, the call originating in the group nearest the one having the preference of the starting circuit, will be completed first. For example, if a call started in group 10, trip unit A and another in group 15, trip unit A, the operation of the (TR) relay in the former group releases the (TR) relay in the latter circuit and remains locked itself. The magnet of the G selector is operated by ground on the armature of the (ST-A) or (ST-B) relays and the brush is advanced one step on the release of the selector armature when the (ST-A) or (ST-B) relay releases after each call.

LINE FINDER DISTRIBUTOR

49. The distributing selectors A and B shown in detail on "The Selector Start Wire Circuit", are used for distributing calls uniformly on the line finder selectors, in sub-groups A and B respectively.

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50. When the number of line finder selectors for a group does not exceed 40 selectors for each 300 lines, the starting circuit should be equipped with two 200-R distributor selectors, and Figure 1 shows these selectors wired and equipped for 16 line finder selectors for each sub-group. When the operation of the (STA) relay in the starting circuit connects ground on the Start lead (ST), as described under ORIGINATING CALL, the (LF) relay which operates, depends upon the terminal on which the A-1 bridging brush is resting. Assume the A-1 brush is resting on terminal 1 in the regular start circuit of sub-group A. In this case if the first selector is not busy, the associated (LF) relay operates and functions as previously described. If the first selector is busy, the associated (MB) relay is operated, and the circuit thru the (LF) relay is opened. In this case, the (LF) relay associated with the next idle selector operates. Assuming this to be the tenth selector, the circuit is then closed from ground at the (ST-A) relay (not shown), thru the break contacts of the (GA) and (C) relays, the A-1 bridging brush and terminal 1 of the A-1 arc of the distributor selector, the ST lead, make contact of the first (MB) relay, in series with make contact with succeeding operated (MB) relays, break contact of the tenth (MB) relay, to battery thru the inner winding of the (LF) relay, which operates. The operation of the (GA) relay as described under ORIGINATING CALL operates the STP-A magnet from ground on the armature of the (STA) relay thru terminal 1 of the (A-3) relay to battery thru the winding of the magnet, so that when the (GA) relay releases at the completion of a call the STP-A magnet releases in turn stepping the selector brushes one step and giving the next selector the preference. When the brushes of the distributor selector advance from the terminals of the last line finder selector, terminal 16, the selector is advanced over the spare terminals to the first terminal from ground on the strapped spare terminals thru the A-2 brush. If a call is made at the time the selector is advancing over the spare terminal it will be routed to the first selector to the A-1 brush and the strapped spare terminals by the strap from terminal 22 to terminal 1 on the A-1 arc.

51. When the number of line finder selectors for a group exceeds 40 selectors, for each 300 selectors, the starting circuit shall be equipped with two 200-P distributing selector, Fig. 2 shows these selectors wired and equipped for 26 line finder selectors for each sub-group. It will be noted that the ST leads from the first 15 line finder selectors in each sub-group are connected in their respective orders to the first 15 terminals for the A-1 and B-1 arcs and the ST lead in the last 11 line finder selectors of each sub-group are connected in their respective order to the first 11 terminals of the A-4 and B-4 arcs. It will also be noted that the brushes of the first three arcs of each selector are in the opposite position from the brushes of the last three arcs so that only three brushes of the selector make contact with the

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terminals at the same time, the other three brushes being open at that time. On a regular call in sub-group A, the circuit functions as described for Figure 1 until the first three brushes of the A distributor selector may advance from terminal 22. Then the first three brushes are open and the last three brushes are now resting on the first terminal, the A-4, A-5 and A-6 arcs. The next call in this sub-group then starts 17 selectors if idle hunting for the calling line. Assume the last three brushes are resting on terminal 11 of the associated arc and the 26th line finder selector is idle. The operation of the (STA) relay in the starting circuit closes a circuit from ground on its armature, break contact of the (GA) and (C) relays, A-4 brush and terminal 11 over the ST lead, thru the break contact of the (MB) relay of the last or 26th line finder selector in the sub-group to the associated (LF) relay. The operation of the (GA) relay operates the STP-A magnet to the A-6 brush and terminal 11. The release of the (STA) relay releases the STP-A magnet, advancing the brushes to terminal 12. Ground on the spare terminals 12 to 22 thru the A-5 brush, advances the brushes of the selector until the first three brushes are resting on the first terminal of the A-1, A-2 and A-3 arcs. A call made while the selector is advancing over the spare terminal will be routed to the first selector thru the A-4 brush, strapped spare terminals by the strap to terminal 1 of the A-1 arc.

52. The number of line finder selectors for a sub-group can thus be arranged by changing the necessary strapping on the selector arc. The operation of the emergency selector for sub-group A and the regular and emergency selector for sub-group B are similar.

ANOTHER SELECTOR RETURNS TO NORMAL WHILE THE CALL IS GOING THRU

53. When the (STA) relay operates on a regular call, ground is connected to the line finder circuit over lead X, so that when the (MB) relay operates, it is held operated thru its outer winding from battery on the armature of the (SL) relay. This locking prevents the (MB) relay from releasing, should the selector return to normal while a call is going thru until the call is safely started. There is a possibility that a circuit may have been closed from ground on the armature of the (STA) relay thru the make contact of several (MB) relays to an (LF) relay associated with some other line finder, but the (GA) relay in the starting circuit, which has not had time to operate and open the ST lead. Then if an intermediate (MB) relay releases due to the associated line finder selector returning to normal when it finds ground on the ST lead and operates a second (LF) relay, thereby starting two line finder selectors for the same call.

TESTING LINE FINDER SELECTORS

54. This circuit which is shown associated with the starting circuit enables the testing of any particular line finder selector at any time. The test line used with the test box circuit to make the test is the first or bottom bank of both the A and B sub-groups, the first line terminals in both sub-groups being connected together.
55. When the 184 plug (shown on the line finder circuit) is inserted in the TEST jack of the line finder under test, the ST and ST-1 leads are connected together. The 1,000 ohm winding of the (LF) relay is disconnected from the break contact of the (MB) relay and connected to the make contact of the (C) relay in the starting circuit thru the strapped ring and sleeve of the TEST plug. When the plug of the test box cord is inserted in either 159 test jack, the (A) relay operates from ground on the sleeve of the test box cord. The (A) relay is quick in operating to precede the (TR) relay in the trip circuit on a simultaneous call. The (A) relay operated, opens the circuit thru the 700 ohm winding of the (TR) and (TR-1) relays in the trip circuit and connects ground to the winding of the (B) relay, which operates. CIRCUIT:- Ground on the make contact of the (A) relay winding and the break contact of the (B) relay, break contact of the (STA) and (STB) relays, to battery on the STP-B magnet. The (B) relay is slow in operating to prevent a call which has just reached the (ST-A) or (ST-B) relay from being interrupted, and to prevent there being a possibility of two selectors being on the test line. The (B) relay operated, (a) locks to battery on its make contact, (b) operates the (C) and (CI) relays from ground on its armature, thru the break contact of the (E) relay, (c) closes the ring side of the loop thru the test box which operates the (L) relay in the test line. The (C) relay operated, (a) transfers the circuit for operating the (ST-A) relay in the starting circuit from the G distributor selector bank, (b) opens the normal ST lead, (c) closes a circuit thru the (LF) relay and TEST jack to the make contact of the (ST-A) relay as hereinafter described, (d) opens the operating circuit to the (ST-B) relay which would otherwise operate and lock on a call within the last ten lines in the group. The (CI) relay operated, (a) closes a circuit to operate the (TR) relay in the trip circuit, from battery on the armature of the STP-G magnet, (b) connects K lead of the sub-group A to the K lead of the sub-group B and thus connecting the K commutator segment of all the selectors of the sub-group together, (c) connects the Y lead of the sub-group (A) with Y leads of the sub-group (B) so the (GA) relay will be operated by a selector in either sub-group.
56. The (L) relay of the test line operated, in turn operates the (BA) relay, the (BA) relay operated, operates the (TR) relay thru its 700 ohm winding over the same circuit as described under

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ORIGINATING CALL, except that this time the circuit is closed thru the make contact of the (CI) relay, the (A) relay being operated. The (TR) relay operated, functions as previously described in paragraph 5 and locks in a circuit thru its 600 ohm winding and make contact, make contact of the (C) relay, break contact of the (CA) and (SB) relays, to battery thru the winding of the (STA) relay, which operates. The (STA) relay operated, functions as described under "ORIGINATING CALL" (paragraph 6) and closes a circuit operating the (D) relay which locks under control of the (A) and (B) relays. The circuit for operating the (LF) relay in the line finder circuit under test, is traced from ground on the make contact of the (STA) relay, the (GA) relay normal, the (C) relay operated, sleeve and ring of the test jack and the plug in the line finder circuit to battery thru the 1000 ohm winding of the (LF) relay. The (LF) relay operated, starts the selector hunting for battery on the H terminal of the test line as in the case of a regular call. With the exceptions already stated, the line, trip, starting, line finder and district circuits function as for a regular call.

57. When the (STA) relay releases, the (E) relay operates. CIRCUIT:- Ground, on the break contact of the (STA) relay, make contact of the (D) relay to battery thru the break contact and winding of the (E) relay. The (E) relay operated, (a) locks to ground on the make contacts of the 9(A) relay, (b) releases the (C) and (CI) relays, thereby restoring the starting circuit to normal, (c) closes a circuit from battery on the STP-G magnet; which was opened by the operation of the (A) relay and later closed by the operation of the (CI) relay, thru the 700 ohm winding of the (TR) and (TR-1) relays. When the plug of the test box cord is removed from the test jack, the (A) relay is released, releasing the (B), (D) and (E) relays, thereby restoring the test circuit to normal.

TELL-TALE - LINE FINDER SELECTOR

58. Should the line finder selector travel to the tell tale position, while hunting, due to the multiple brush not being tripped, the (F) relay remains operated thru its outer winding. Ground on the X commutator, brush and segment is thereby connected to the lead "TO TELL TALE CIRCUIT", giving a visual signal to the attendant. As the N commutator segment is open at tell tale the district is prevented from advancing from its normal position. The selector in this case is restored to normal, manually, by the attendant.

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issues.

59. Should the line finder selector travel to the tell tale position, while hunting, with the multiple brush tripped a circuit is closed from battery in the trip circuit, 500 ohm winding of the (O) relay in parallel with the 500 ohm resistance, make contact of the (BA) relay, terminal of the H comb at the top of the multiple bank H multiple brush of the line finder selector, cam W, winding of the (H) relay, to ground on the break contact of the (DS) relay, operating the (O) and (H) relays. The (O) relay operated, functions as previously described in paragraph 12 and the (H) relay operated, releases the (LF) relay which in turn releases the (F) relay. The UP magnet is released by the opening of commutator N at tell tale position. The (F) relay released, opens the circuit thru the tell tale alarm and connects ground on the X commutator brush and segment to the (DS) relay which operates, in turn operating the DOWN magnet, restoring the selector to normal.
60. If the receiver at the calling station is still removed from the switchhook, the (L) and (BA) relays are still operated and the call again goes thru as described under "ORIGINATING CALL".

TELL TALE - DISTRICT SELECTOR

61. Should the district selector travel to the tell tale position during selections, ground on the X commutator brush and segment is connected thru the lower inner contact of cam B, to battery thru the R magnet, advancing the switch to position 8. If the district selector traveled to tell tale during brush selection, the switch will remain in position 8 with its attached sender. If the district selector traveled to tell tale, during group selection, the sender will function and connect 500 ohm ground on the SC lead causing the (CH) relay to operate, which in turn operates the (L) relay. The (L) relay operated, advances the switch to position 9, where it is held with its attached sender. After an interval of time alarm is given by the sender and the circuit is restored to normal manually.

OVERFLOW

62. If all trunks in the group are busy, the district selector while trunk hunting in position 7, travels to the top of the group and rests on the overflow terminals. As the sleeve terminal at overflow is opened, the (L) relay releases in turn advancing the switch to position 8. In position 8, the (L) relay reoperates from ground on the armature of the (CH) relay and advances the switch to position 9. In position 9, a circuit is closed from ground on the Z commutator brush and segment, thru the upper contacts of cam K, to battery thru the R magnet, advancing the switch to position 10. As the switch advances from position 9, the (L) relay releases. In position 10, a

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circuit is closed from ground on the Z commutator brush and segment, cams K and L, to battery thru the 1200 ohm winding of the (L) relay, which operates. The (L) relay operated, locks thru its 1200 ohm winding and make contact to the same ground on cam L advancing the switch to position 14 from ground on cam M. As the switch advances from position 13, the (L) relay releases. The (L) relay released in position 14 advances the switch to position 15. The release of the (L) relay also releases the (CI) relay, disconnecting the sender from the district circuit. With the switch in position 15, a circuit is closed from the Miscellaneous Tone Circuit over lead G, 2 m.f. condenser upper contact of cam G, winding of the repeating coil, 2 m.f. condenser, cam Y, upper contacts of cam V, cam J, make contact of the (D) relay to ground. A tone is therefore induced in the other winding of the repeating coil, thus causing the "All Trunks Busy" tone to be sent back to the calling subscriber. When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, opening the locking circuit thru the (D) relay, which releases. From this point on, the switch is advanced to position 1 as described in paragraph 39.

"0" COMMUTATOR

63. The function of the "0" commutator segment is to maintain an idle condition on the multiple overflow terminal so that more than one selector may stop at overflow at one time, otherwise the first selector reaching overflow will make the sleeve multiple terminals busy, thus causing the succeeding selectors to continue upward, into the next group of trunks. The "0" commutator segment is open at overflow, but the S bar is continuous. When the "0" and "S" commutator brushes are permanently strapped together and wired to the multiple sleeve brush. When the selector is at overflow, the "0" commutator brush is resting on an open (dead) segment and as the busy ground is fed thru the "0" commutator bar only, this arrangement maintains a non-busy condition on the sleeve terminal. When necessary to combine two or more groups of trunks the multiple sleeve overflow terminals, between the combined groups may be made permanently busy by being connected to ground. As the "S" commutator bar is closed at overflow, the (L) relay is held operated at this time and the selector therefore hunts past the make busy terminals into the next group.

TERMINATING CALLS

64. When a final selector connects to the tip, ring and sleeve terminals of an idle line at the final multiple, battery thru a resistance in the final circuit is connected over the sleeve lead S, to ground thru

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both windings of the (CO) relay, on individual lines and the last line of a group of P.B.X. lines or thru the 100 ohm winding of the (CO) relay on an intermediate of a group of P.B.X. lines. The (CO) relay operated, disconnects the (L) relay battery bridge from across the tip and ring of the line circuit. When the final selector returns to normal, the circuit thru the winding of the (CO) relay is opened, releasing the relay and restoring the circuit to normal.

ENG. A.X.D.
6-13-23

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25-1-16-79

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